656

Ten Years Progress at the Four Regional Research Laboratories

P. A. WELLS

USDA Eastern Regional Research Laboratory

Philadelphia, Pennsylvania

Establishment of the four Regional Laboratories in 1938 represented the culmination of efforts by many individuals and organizations, including the NATIONAL FARM CHEMURGIC COUNCIL, who were interested in the welfare of agriculture. The legislation authorizing the new laboratories was contained in the Agricultural Adjustment Act passed in 1938, and it stipulated that the purpose was "to conduct research into and to develop new scientific, chemical, and technical uses and new and extended markets and outlets for farm commodities and products and byproducts thereof. . . . Such research and development shall be devoted primarily to those farm commodities in which there are regular or seasonal surpluses." Later the Congress expressly included work on new and improved food products.

Dr. Wells

" . . . regular or seasonal surpluses"

Our charter represented a new front of attack in the general program of the Government on the major agricultural surplus problems which then existed. In essence, too, it represented a major challenge to science and technology to aid in solving this farm problem. Events that followed the initial declaration of purpose demonstrated that the program must be far broader in scope than the matter of surpluses. World War II intervened almost before we had finished moving into the new laboratories, and our whole program had to be reoriented. In view of this circumstance it is of interest to review some of the things that we thought and felt about the potential value of this research. The following is quoted from our survey report made in 1938: "In setting up an initial program for these laboratories, the principle of 'first things first' has naturally been followed. An acute surplus situation exists in certain crops, and the intent of Congress is to bring this new attack to bear on this problem as speedily as possible. The program as now set up is intended to do exactly that. Nevertheless, one familiar with economic history must be aware that with the passing of years such situations change greatly. In other words, this agricultural surplus problem is not static, and plans should not be made on the supposition that it will remain fixed and unchanged.

"One inevitable result of the proposed program is that basic chemical research will lead into fields where economic factors will be decisive—where such questions as competition between products, the effect of changes in farm practice in a given region, the relations of tariffs to new forms and uses of a product, the effect of an altered international trade situation, the bearing of this or that line of research on national defense and like questions, must be met and answered. . . . For the long-range view, these laboratories will require a flexible program. It is unlikely that the research and educational patterns which fit our present-day needs will exactly satisfy them in the future.

"One certain and permanent value of these laboratories will rest on the fact of their actual physical existence. Such institutions, with their extensive equipment, libraries, and trained technical staffs, cannot be brought into being overnight. Once actually established they can be reckoned as productive national assets."

Program Enlarges in War and Defense

War problems required that our program be enlarged to embrace the whole broad field of farm product utilization and this reorientation was accomplished within a short time. Since we were not in full operation when disaster struck at Pearl Harbor we were plagued with many of the usual wartime headaches in getting equipped. The situation in the present emergency is quite different and we are able to carry out our current defense program much more effectively.

All-direction Cooperation

There is one all-important aspect of our operations to which I wish to give emphasis before turning to a consideration of our progress in particular fields. It is in our external cooperation—our working together with large and small industrial companies, private research organizations, universities, other Government agencies, state experiment stations, farm cooperatives, and others—where I think new highs have been set through the ten years of our operations. A number of commodity associations have established fellowships in the Regional Laboratories and have fused their efforts with ours. On many occasions industrial firms have opened to us not only their specialized research facilities, but their production lines as well, for experimental use.

I want to stress one further point about this "report of progress." It is merely a sketch which indicates the direction of things we've done and are doing. As soon as I received the assignment I knew what an impossible task it would be to cover the subject in half an hour or so. I decided to throw part of the burden of material selection and preparation on my Director associates in the other Regional Laboratories. I allowed each of them ten minutes speaking time to tell what they've done in the past ten years! One of them wrote me: "The length limitation has made our task most difficult. A preliminary list of the accomplishments which really deserve description came to more than 50 separate items. We were able to get in a sketchy description of only about 15 of them, plus the bare mention of about half a dozen more."

With this thought in mind, let us look at some of the things we've been doing.

New and Improved Industrial Products

——Natural Rubber in U. S.

Very shortly after the new Regional Laboratories were occupied, in 1940-41, the increasingly dark outlook for the war then raging in Europe made us take a very sober look at our national resources. American agriculture, it was clear, would be called upon for extraordinary feats of production. More than that, American farms might well have to produce many materials which we were accustomed to import from overseas.

One of these essential materials was rubber. Nearly all of the rubber which went into tires had to be carried all the way across the Pacific. Development of *domestic* sources of rubber took on urgency.

Agriculture contributed largely to development of an American synthetic rubber industry by growing crops which, converted first to alcohol, then to butadiene, furnished an essential ingredient of GR-S, the government synthetic rubber.

But concurrently there was another significant development—in investigation of the feasibility of growing natural rubber on American soil. A small industry had existed for some years in Northern Mexico which recovered an impure rubber from a wild desert shrub known as guayule. Most of our effort was put on this plant. Acreages were established in California. Laboratory, pilot plant, and full-scale plant facilities were put into operation. Domestic guayule rubber was being produced before the war's end.

This is significant for, good as our synthetic rubbers are, they are seriously deficient in certain physical properties which are critical in heavy-duty automotive tires. While the wartime emergency research on guayule demonstrated that rubber could be grown in the U. S., the rubber recovered by processes then known was not equal to Malayan rubber for heavy tires. At the end of the war, when trade with the Far East was resumed, the project was dropped.

Four years ago, when international tensions again built up, the guayule research was picked up once more. Our Bureau was to improve the recovery of rubber from the shrub. We are glad to report that this research has been most successful. By a combination of improved processing methods and a purification of the recovered rubber we have been able to produce a rubber which is in every respect the equal of Malayan plantation rubber. Several tons were made in our pilot plant. Some of this was used to fabricate heavy-duty truck tires, and these were road-tested under severe conditions. Their performance equaled that of tires fabricated from Malayan rubber. One of these guayule tires, which had run more than 50,000 miles without failure, is on exhibit in this hall. *We now know that we can produce, within the United States, natural rubber which is fully capable of meeting an critical need which may arise.*

—Penicillin Use Expanded

How penicillin was found, how its dramatic healing properties were discovered, and how the miracle of its production during World War II took place, is undoubtedly well known to you. Our Bureau's work brought two important discoveries. The first was the discovery of a basic nutrient medium for growing the mold which greatly increased the yield of penicillin. The second was the discovery of the species of penicillium mold that is the parent strain of all those now used for penicillin production. Important new outlets for two farm products, milk sugar and corn steep liquor, were brought into being, but the values which can thus be assigned to this aspect of the penicillin development must be regarded as merely incidental.

It is useless to attempt evaluation of the lives saved by the use of penicillin. Yet we do have fairly accurate knowledge of what production of the drug has meant commercially. During the first 6 months of 1951, the bulk wholesale value of penicillin was about $67 million. From reports manufacturers have supplied us, the plants now producing penicillin and other antibiotics represent a capital investment approaching $250,000,000. We can also look upon the penicillin development as ushering in the vast new era of antibiotic research and production. It is continuing to expand, not only in producing drugs for human use, but also for the feeding of livestock and poultry.

—Starch Sponge for Surgery

We have succeeded in adding an important industrial use for corn starch by development of a product called "starch sponge." Producing it is simplicity itself—merely making a paste by heating starch in water, then slowly freezing it over a period of about 24 hours, letting it thaw, pressing out the water, and drying the resulting mass. The dry sponge is brittle and light in weight. The fineness or porosity can be varied as desired. A surgeon decided it might prove an excellent hemostatic agent. Clinical trials indicate it is of especial value in hemorrhage during childbirth, and in many types of surgical operations. In powdered form it makes an excellent

"MATCH THIS SAMPLE." That is the current instruction—and often the most important—when the farmer buys his fertilizer. Eight attractive girls from Bemis Bag Co., St. Louis, model chemurgic "reasons" for the new instruction. Their frocks were made from fertilizer bags.

Commander J. W. Leek of the U. S. Coast Guard's St. Louis District, a guest at the NFCC luncheon, stands behind Alice Muniz. The other models, *left to right,* are: Nancy Maczko, Bernice Rotz, Geraldine Wiedner, Mary Louise Statler, Audrey McCrory, Glenna Butler, and Paula Hancock.

facing for gauze bandages, allowing them to be removed without tearing newly formed tissue or dislodging surface clots of blood. The material is readily absorbed by the body if left in a wound. The sponge is available in quantities for the clinical trials now being given in a number of hospitals and by the army medical services.

——Allyl Starch Goes to Work

Our research has produced another new product from starch called allyl starch. It is made by treating starch with allyl chloride, a product of the petroleum industry. Freshly made allyl starch is freely soluble in organic solvents such as alcohol, acetone, benzene, toluene, and xylene. When dissolved, it can be brushed or sprayed on wood, glass, or metal like any lacquer. After the film hardens it becomes highly resistant to the action of solvents and chemicals, as well as high temperatures. Allyl starch has been tested for furniture finishes, interior wood finishes, heat-resistant adhesives, as a printing ink vehicle, and for numerous other applications. It is being produced on a limited commercial scale at present, and most of this production goes into specialty uses. If present attempts to introduce allyl starch as a furniture coating are successful, the production will be increased many-fold.

——Casein Bristle Fiber

Casein bristle fiber is another product developed as a result of our research. To make it, a little water is added to powdered casein (the principal protein of milk), and the mixture forced through small holes under heat. Chemical treatment is used to harden the fiber and give it flexibility and strength. It is being produced commercially and is used in automobile carburetor air filters and for mattress stuffing. There is a big potential market for the fiber for furniture stuffing, paint brushes, and in the manufacture of stiff cloth.

——Rutin, Rx from Buckwheat

A new drug called rutin, the domestic source of which is the green buckwheat plant, has come into widespread commercial production as a result of our research. It has been found effective in restoring the walls of weakened capillary blood vessels to normal strength, and the medical profession has demonstrated the drug's effectiveness in treating a wide variety of hemorrhagic conditions. Rutin has been shown to afford substantial protection against the harmful effects of X-rays, indicating that it may benefit persons exposed to dangerous atomic radiation. At least 20 companies in the U. S. are producing rutin.

——Zein Fiber in Textiles

Many of you, without knowing it, may be wearing corn—that is, zein fiber made from corn. For over a year, articles containnig the fiber have been appearing in sweaters, socks, the upholstering or furniture, or mixed with rabbit fur in felt hats. Zein, a protein of corn, is obtained from corn gluten, a by-product in corn starch manufacture. Zein fiber is the nearest thing to wool that man has been able to make, and it doesn't scratch. Moths don't like it and carpet beetles do not eat it. It blends well with other fibers such as wool, cotton, nylon, and rayon. It improves the draping qualities of many products in which it is used. And fabric blends containing zein fiber launder and dry-clean well. Zein fiber is a distinct contribution to the field of textiles. A Connecticut plant is producing some 4 to 5 million pounds annually.

——Acetylated Cotton Resistant to Heat and Rot

Cottons that are virtually new fibers with new and improved properties have been prepared by methods of chemical modification, that is, by processes that change the molecular structure of the cellulose of which cotton fiber is largely composed.

One such cotton is called "acetylated cotton." It has received considerable attention because of its outstanding resistance to rot, mildew, and heat, thus giving unusually long service-life in tests of sand bags exposed on damp ground, bags for holding chemicals in home water-softening systems, nets and twines for fishing gear in river and ocean waters, and most recently in tests of hot-head press covers and ironer covers in commercial laundries.

The process for producing acetylated cotton employs glacial acetic acid and acetic anhydride, with perchloric acid as a catalyst, to convert the cellulose of the cotton to a partial acetate. The cotton remains nontoxic and is not changed in appearance. Unlike some processes used to improve cotton's rot resistance, partial acelylation leaves no stickiness, odor, or color. It is believed to be the most effective method so far developed to protect cotton from rot-causing microorganisms and from damage by heat.

We are cooperating with more than a dozen firms in an effort to develop the process to a commercially feasible stage and to evaluate the possibilities of acetylated cotton in additional end uses. A pilot plant process for acetylating cotton in fabric form is now regarded as practical, and considerable progress has been made in the treatment of yarns. The production and processing of acetylated fiber is also being investigated.

——Improved Cotton Bandage

An improved material for surgical bandages has been made by chemically treating ordinary cotton gauze. This material may soon be made commercially. The gauze is easily stretchable in any direction. It conforms readily to body contours, yet allows freedom of movement; hence is especially suitable for dressing injured joints. Because the springiness of the material tends to make it self-tightening, as well as stretchable, the gauze is also suitable where light pressure on a dressing is desired, as in the case of burns and skin grafts. More than 3000 of the new type bandages have been tested by the Army, in hospitals and in field trials, some in Korea. They were considered better than any others available for securing the newly-developed Evans pads to multiple wounds and large burned areas.

The process for making the bandages involves allowing cotton gauze to shrink freely, and completely, in a caustic-soda solution of about 20 per cent concentration, then washing out the caustic and neutralizing with a weak acid, followed by a thorough washing, then drying—all without removing any of the crimps and kinks upon which depend the elastic properties of the dried bandage.

——Nutritive Cottonseed Meal

Investigations have led to more extensive utilization of cottonseed meal as a source of protein in hog and poultry rations, as well as in feeds for cattle. Experimental cottonseed meals have been fed to hogs in concentrations as high as 43 per cent of the total diet, and to chicks in concentrations up to 70 per cent of the diet, without any harmful effect and with good support of growth. Heretofore, recommendations have called for concentrations not to exceed 10 per cent for hogs and as little as 5 per cent for chickens.

Approximately 2 million tons of cottonseed meal, valued around $150 million, are produced annually in the United States. When this development has been adapted for widespread application in the cottonseed processing industry, it should make the crop much more valuable by expanding the market for cottonseed meal.

New or Improved Food Products

—Food Preservation

The process of getting food products from the farm to the consumer has undergone a thorough transformation during the past two or three decades. I am sure we would be startled if we could perceive all at once how great its extent has been—for example, if we were able to take a good look inside a grocery store in the year 1915 or 1920.

Strong and deep economic currents have brought about these changes. From the consumers' side the urges are toward wide variety of choice without much seasonal fluctuation, dependable and easily recognizable quality, convenience of preparation for the table, and economy. The farmer needs an assured market for his crop at harvest time, relief from seasonally glutted markets, and growth of demand for products which will give him decent recompense for his invested money and labor.

By means of modern science and technology, even eggs, milk, green peas, sweet corn, strawberries, and orange juice can be made available to the consumer all the year around in a state of dependably high quality, and the farmer's market is expanded and stabilized.

—Frozen Foods

Our laboratories have given special attention to frozen foods and to various food concentrates. Frozen green peas and frozen orange juice concentrate are typical examples. These food products may be so excellent that even a trained test panel cannot surely distinguish them from high-quality fresh products. But in the processing flow-sheet for either of them there are a dozen vulnerable points—a little slip at any one of them and the target is missed. Food concentrates are not only important to our civilian economy, but also are given top priority by our military planners. Consider spray-dried egg powder. A No. 10 can of this powder—about 6 inches in diameter and 7 inches high—will make scrambled eggs for 50 servings; it takes the place of 8½ dozen shell eggs. Within the past three years significant further improvements of egg powder have been discovered and put into commercial operation. The present-day dried egg powder is so stable that even after 6 months of storage at 100° F. it will still make highly palatable scrambled eggs or a light, fluffy sponge cake. A product like that not only interests the armed forces, but is also just what is wanted by the manufacturers of packaged dry cake-mixes. Here we have a development which may go far to smooth out the seasonal gluts which have plagued egg producers.

—Frozen Concentrates

Research conducted at the Winter Haven, Fla., station of our Bureau, in cooperation with the Florida Citrus Commission, led to the development of frozen concentrated orange juice, familiar to housewives the country over. Nearly 31 million gallons, having a market value of well over $100 million, were produced in Florida alone during the 1950-51 season. This use of oranges has returned tens of millions of dollars each year to the grower and, perhaps more important, has prevented the development of glutted orange markets with severely depressed prices.

In addition, a delicious, wholesome product easily reconstituted for consumer use, has been provided. Frozen concentrated orange juice is extremely popular because of its fresh-fruit flavor, as well as its convenience to the housewife. The process for producing it involves the evaporation of orange juice to a concentration of about 60 per cent solids, followed by the addition of fresh juice to reduce the solids to about 42 per cent, and then freezing.

Improvements are constantly being made in the original process. Frozen concentrated grape juice, pineapple juice, apple juice, tomato juice, and even frozen concentrated coffee, are on the market, produced by essentially the same process.

—Other Food Concentrates

Still another kind of food concentrate developed in our laboratories, but not yet in commercial production, is a partially dehydrated fruit or vegetable. If about half the water is evaporated from apple slices, fresh prunes, apricot halves, or green peas, substantial savings in packaging, storage, and transportation costs may be realized. The products are still very moist, so they must be preserved either by freezing or sterile canning. We have called the former dehydrofrozen, the latter dehydrocanned, foods.

And we've found a way to give real maple sirup several times as much flavor as it has when made by the usual method.

—Edible Soybean Oil

Americans demand a bland, stable soybean oil for their food products, which will not develop the variety of flavors its habitually accumulates if it is not used within a few days after refining. Also, the processors want the oil to remain fresh and tasteless on grocers' shelves sometimes for as long as 6 months. The problem has received much attention because more than half of the oil used in margarine and vegetable shortenings is soybean oil. Bureau research adaptation of a German discovery that citric acid added to soybean oil during refining has increased the oil's shelf life. Recently we have discovered that a product derived from corn—phytic acid—is superior to citric acid in certain methods of stabilizing the flavor of soybean oil. The use of phytic acid awaits completion of chronic toxicity tests. We have established that trace metals and linolenic acid are major factors in the rapid development of off flavors.

—Riboflavin, Vitamin B_{12}

Two microorganisms have been tested and methods developed for their use in the production of two essential vitamins—riboflavin or B_2 and B_{12}. The organism which produces riboflavin is a disease agent that has given a lot of trouble to cotton farmers in the African Sudan. By the methods developed, there is no danger that the organism will escape to our cotton fields. Today the Bureau's method is in use to produce riboflavin largely for use in livestock and poultry feeds. The production of vitamin B_{12} is based on the use of an organism isolated from a soil sample sent back to this country from the Orient by a Bureau employee. Although our organism and method for B_{12} production have been available to industry for only about a year, they are already the source of greater supplies of a very important supplement to livestock feeds.

New or Improved Processing Methods

The new products I have been speaking about were not developed without simultaneous attention to the processes which could make them practical realities. Many significant new techniques, process combinations, and types of processing equipment have come out of this work. I shall have time to mention only a few of them.

One of these improved processing methods is a new way of applying direct steam injection to the rapid heating of liquid food products. Such food liquids as milk and fruit juices have delicate flavors that are easily ruined by even a little exposure to high temperatures. Yet, if the heating time can be made

"THERE IT IS." In picture *below*, George F. Jordan, from the Bureau of Agricultural and Industrial Chemistry Laboratory at Peoria, Ill., points out his headquarters to fellow workers of the Department of Agriculture. Looking on, are Dr. P. A. Wells, *left*, Director of the Eastern Regional Research Laboratory, one of the conference speakers, and Frank Teuton, *center*, Director of Information for BAIC in Washington.

Legend of guayule tire, *right below:*

This — the first successful truck tire ever built of guayule rubber— was made possible through progress in the research work of the U. S. Natural Rubber Research Station in Salinas.

Carcass construction is 100% guayule natural rubber with thread made of synthetic "cold" rubber. Road tests, in which the tire was run continuously at 45 MPH with approximately 40% overload, were made by the office of Rubber Reserve, Camp Bullis, Texas. Guayule proved to be the equal of regular plantation rubber in these tests.

Guayule shrub from which the rubber was obtained was grown in the Salinas Valley by the Bureau of Plant Industry, Soils & Agricultural Engineering. The rubber was extracted and purified by the Bureau of Agricultural & Industrial Chemistry using improved processing methods.

This tire, one of a test lot, was fabricated by the Firestone Tire & Rubber Company, Akron, Ohio.

short enough, no perceptible damage will occur. One of our laboratories has applied direct steam injection so that it is now possible to heat a flowing stream of liquid to 280° F., or higher, flash off a portion of the liquid as vapor, and return the liquid to room temperature, all within an elapsed time of less than one *second*. Under these conditions little or no change occurs in the delicate flavoring constituents. This process is now being used commercially in several plants which are processing fruit juices.

Our laboratories have conceived their responsibility to the farmer to extend to such improvements in commercial processing methods as would minimize waste and improve efficiency, and thus help to safeguard the primary market for the farmer's produce. A good example of the working out of this conception is the development of a froth-flotation cleaner for green peas in one of the Bureau's laboratories. By utilizing the difference in wettability of peas and nightshade berries, the latter can be made to float and the former to sink in a continuous flotation machine.

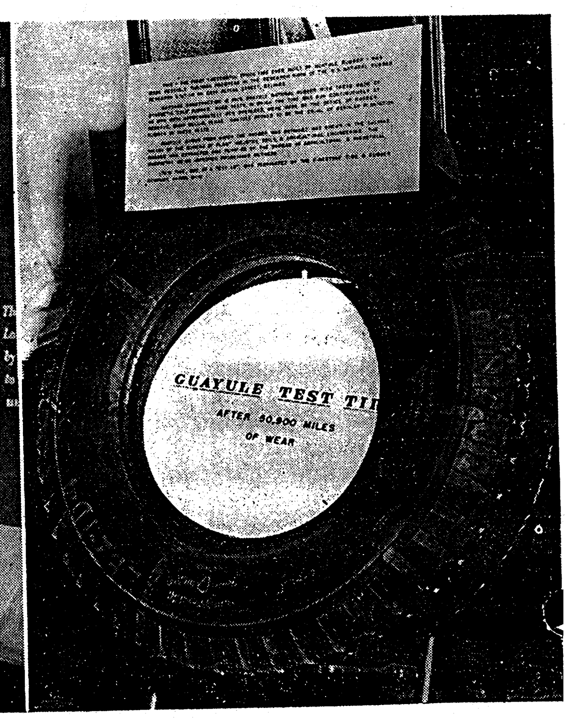
A successful development in a completely different line of endeavor illustrates the kind of dividends that may be paid by a program of research that at first seems to be completely basic, abstract, and of no practical significance. I refer to the work of one of our laboratories on the structure and characteristics of keratin proteins, the main constituents of hair, hoofs, and poultry feathers. They maintain their shape and strength against the attack of air, sunlight, water, and most other natural agencies. Chemists found one quite simple treatment which promises to open up a new source of bristles for paint brushes, and to provide a profitable outlet for many tons of waste poultry feathers.

A new type cotton opening machine has been developed for use in textile mills. Before cotton can be processed, that is, cleaned, carded, spun, and woven, the matted or compacted masses of fiber must be opened or fluffed up. The new machine can process 2,000 pounds of cotton per hour, and savings amount to as much as $2 per bale of cotton processed.

Wet vegetable-tanned leathers have a tendency to shrink and become hard and stiff when dried. To meet this problem we developed a process for retanning vegetable tanned leather with aluminum salts. This twice-tanned leather has remarkable resistance to the action of moist heat; in fact it can be boiled in water for several minutes with only slight shrinkage.

A process for preparing high purity oleic acid, an improved grade, resulted from our research and has provided a basis for greatly expanding the outlets for animal fats.

Our research developments have transformed a once primitive gum naval stores industry into a highly modern one giving economic benefits to an estimated 400,000 persons. The service life cotton cloth used to shade seed beds and growing tobacco plants can be at least tripled by a lead-chromate process developed recently in one of the Laboratories.



Developments in Utilization f Agricultural Wastes

Chemurgists have always taken a special interest in the creation of new values from so-called wastes. Our laboratories have expended much effort in that direction, believing as we do that the cost of simply disposing of agricultural wastes is a dead economic weight. If the size of the pie to be divided can be increased, by finding a market for these wastes, the farmer, the processor, and the consumer all can get bigger slices.

——Pear Waste Food and Feed

In some parts of the U. S. the wastes from fruit canneries have become a serious nuisance, and their disposal has been a significant item in the cost of operating a cannery. The waste from pear canneries has been especially troublesome. Conventional methods of pressing and drying it have not been successful. Two of the Bureau's laboratories have attacked the problem within the last few years. Separate lines of investigation were followed; both have been successful. One was based on the premise that a large proportion of the peels and cores freshly separated from the fruit contains perfectly wholesome food material. The process finally developed segregates this sound fruit material from inedible portions and then treats it so that a clear colorless juice is finally recovered. This juice can then be used as the sirup needed for the canning of the pears. About one-third of the sugar required for canning a fancy grade of pears can thus be saved.

The other line of attack on the pear-waste problem was based on the supposition that in some circumstances the cannery could not easily segregate edible trimmings, and that a process which could handle the entire solid wastes of the cannery was needed. Our research went into three successive years of large-scale pilot plant work, financed in part by a group of canneries and fruit growers. Its successful culmination came from a combination of careful process development and the invention and perfection of two new pieces of processing equipment. Last fall this pilot plant handled more than 1,700 tons of cannery waste, taking it as it came. A juice separated from the waste was concentrated into molasses, and the residual solids were dried to a fibrous pulp. In feeding tests both of these products were shown to be good livestock feed. Large-scale industrial development of the process is expected to occur this year.

——Corncob Grits for Cleaning

Corncobs have been writing a chapter of their own. Today about 600,000 tons of cobs are being used commercially. Of this amount, 400,000 tons are going into furfural manufacture, with about 200,000 tons going into industrial and agricultural uses for such applications as soft-grit blast cleaning, and for litter and feeds. Credit for the rapid rise of cobs for furfural belongs to the research of one of the large cereal companies. On the other hand, it was our Bureau scientists who started the processing of cobs for industrial use when, during World War II the Navy sought soft grits for the cleaning of airplane engine parts. For such use it was necessary to have a blasting material that would clean the metal but which would cause no dimensional changes. Out of that pioneering work there are today 24 plants processing cobs, and 9 plants grinding nut shells. Probably an additional dozen grinding plants will be established this year. Recently it has been shown that cobs are very valuable as a part of cattle feeds and as an absorbent for liquid feeds. Cob grits are now used during the manufacture of steel plate in rolling mills; in burnishing ammunition shell cases, cleaning glass, hard rubber, and plastics molds, and they are especially effective in cleaning large electric motors and generators.

——Paper and Board from Straw

Increased use of paper and paperboard containers is an outlet for straw, a farm material in plentiful supply. Our studies on methods of pulping straw, on characteristics of straw fibers, and on the effectiveness of various cooking chemicals, have resulted in lowered manufacturing costs, and have enabled production of board products of superior strength and usefulness. We have also demonstrated that straw pulp can replace up to 20 per cent of the wood pulp now used in the manufacture of newsprint.

——Vegetable Waste Deodorant

Vegetable field wastes occur annually to the extent of about four million tons. We have developed commercially practicable methods for dehydrating vegetable field and processing wastes to produce vegetable leaf meals suitable for use as feeds and for extraction of valuable chemicals. Besides carotene and tocopherols (vitamin E), leaf meals are rich in sterols, chlorophyll, and xanthophyll, which can be removed by extraction with solvents. Chlorophyll, the green coloring matter of plants, has found use as a therapeutic agent, and recently has come into widespread use as a deodorant.

Fundamental Contributions to Industry and Science

I know you are aware that research is an unpredictable sort of activity. Sometimes the research man for years bats his head against obstacles which seem like unyielding stone walls in every direction—and then sometimes the very same man suddenly finds a clear pathway leading through the obstacles to the promised land beyond. During the past ten years many noteworthy examples of basic research have come out of the Bureau's laboratories. As is the case with all such research, once the results are published other investigators all over the world add the new knowledge to their own equipment, and applications may be made in the most unexpected directions.

Enzyme chemistry is surely one of the more abstruse branches of that science, but the wonderfully intricate enzyme actions by which Nature accomplishes the phenomena of organic life are of immediate concern to every technologist who deals with farm products. In a recent fundamental study in enzyme chemistry one of our researchers discovered in plant materials an enzyme known as phosphotransferase, and established that it is one of the essential cogs in the intricate machinery that transforms dead chemicals into living tissue. Insights like this may some day give us greater control over plant growth and the processes of maturation and ripening.

Our work on the water absorption of proteins represents a basic contribution to scientific knowledge. Another fundamental contribution is our study of the proteins of milk. The second most abundant milk protein, beta-lactoglobulin, looks as if it is really more than one protein, and we are still tracking that down. Casein, of course, is the most abundant protein of milk and has many commercial uses. Some 70 million pounds are used in this country annually.

Still another fundamental contribution is our work on the oxidation of oleic acid, one of the principal constituents of animal fats and oils. Work here and abroad in the last 10 years has provided more understanding of fat oxidation than all the work of the preceding 100 years. Scientific information necessary to bring animal fat products to an important position as chemical raw materials is being rapidly accumulated.

A stream of new research techniques

and instruments has also come out of the Bureau laboratories. They range all the way from new techniques for separating and identifying organic compounds by means of chromatography to new and simpler methods of designing food dehydrators. In many of these cases the scientist found he had to invent a new tool before he could get on with the job, and, in the sound tradition of the sciences, he has made the new technique or the new instrument available to all who may have need of it.

One such new tool we invented is an instrument called a photoelectric light-scattering photometer. It works by measuring the way a beam of light is broken up as the beam passes through a solution. We have used this tool to study casein, starch, synthetic rubber, fatty acid derivatives, pectins, and proteins to determine the molecular weight of these polymers. Our new tool works faster than any previously used to find molecular weight, and it gives us more information about the molecules.

Now, it's a funny thing about a new tool like that. Our molecular weight tool is now being used to study the blood plasma substitute, dextran. Here the molecular weight is critical; if it's too low, the dextran filters out of the body; if it's too high, the dextran induces a fever. So we have an example of a tool, invented to expedite agricultural research, being put to work on a project that will save precious lives.

As an example of the discovery and development of a new research method, I cite the photochemical oxidation of certain substances in the presence of the dye, methylene blue. We half-stumbled across this peculiar reaction when we were studying nicotine. We found that the particular place in the nicotine molecule which is oxidized includes the nitrogen atom. And a knowledge of the chemistry of the nitrogen atom is all important in our understanding of proteins—and proteins, everyone knows, include viruses, and enzymes, and some hormones, all of which play a potent role in the well-being of men.

What About the Future?

The Regional Laboratories have now entered the second decade of their operation, and on this occasion I think we should yield to the temptation of peering into the future to see, if we can, what lies ahead. I think we can feel with confidence that much of the general background of our future is accurately mirrored by our past accomplishments. If our present research potential is maintained, I think we should certainly expect that our future achievements will be at least as great as tho of the past. I think that is a reasonab expectation, but, as in 1939, we say again that much of this future development is in the realm of the unpredictable and the unknown. This, of course, is the very essence of what is meant by research, so that our hopes for the future actually are based on "the faith that knowledge is a better guide to human action than ignorance."

TEN YEARS OF CHEMURGY

Dr. Wells made an outstanding report of 10 remarkable years of CHEMURGY in the Department of Agriculture's Regional Laboratories. His address appears here in condensed form. Space limitations made this regrettable reduction necessary. Copies of the complete text of Dr. Wells' address, as well as complete texts of other conference speakers, are available from:

National Farm Chemurgic Council
350 Fifth Avenue
New York 1, N. Y.